Characteristics of Extreme Summer Convection in the Tropical Americas

Manuel D. Zuluaga and Robert A. Houze Jr.
University of Washington

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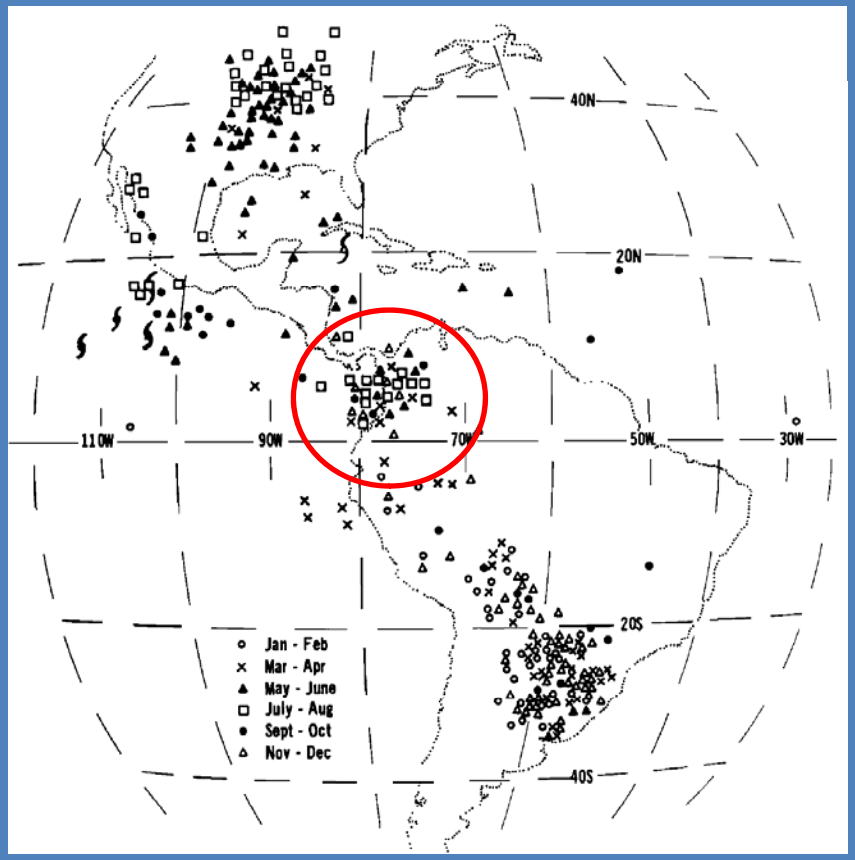
Motivation

- MCC “hot spots” over the Americas
- Severe weather and flash floods
- Much has been done over mid-latitude areas of North and South America
- Less where the ITCZ intersects the Andes



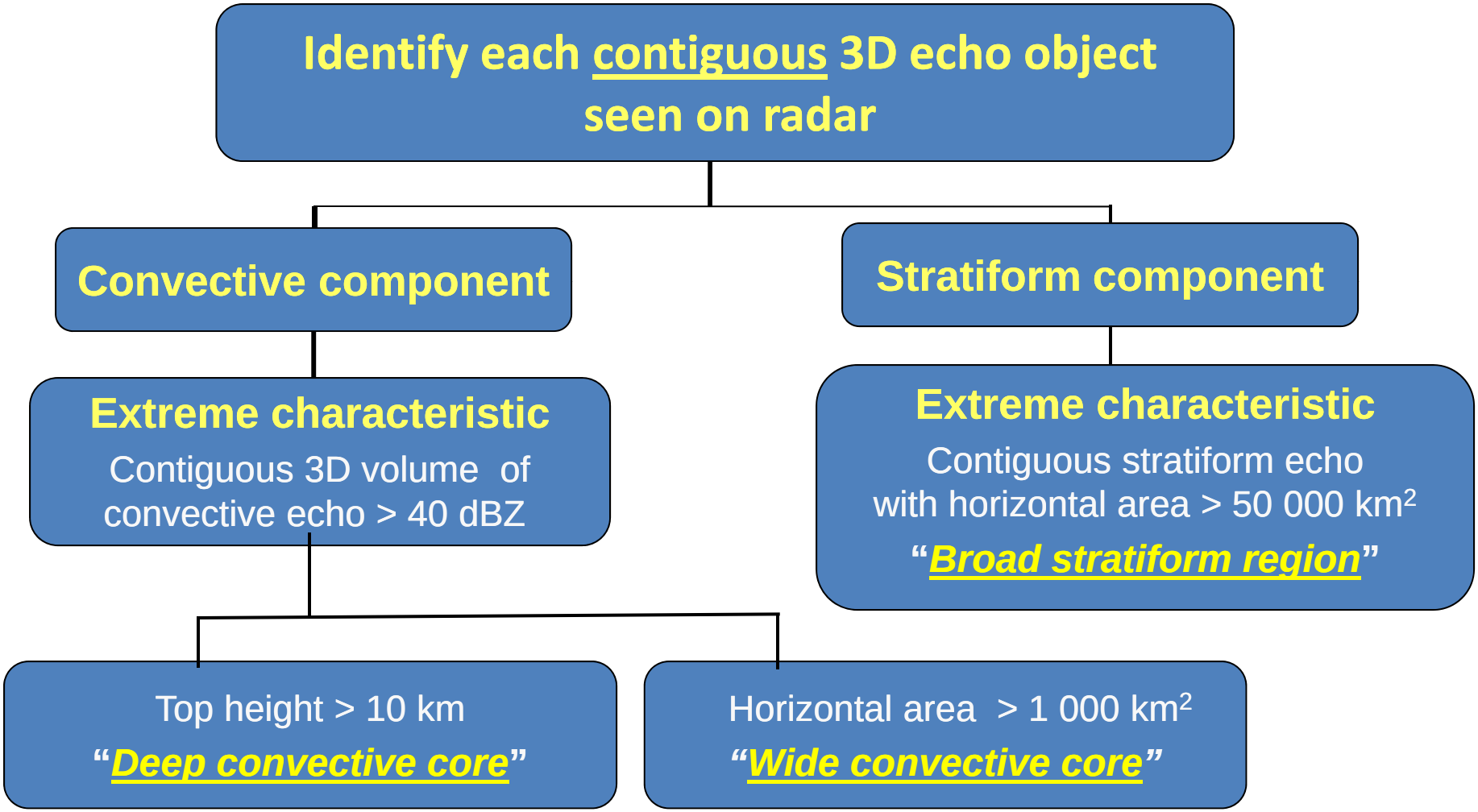
Velasco and Fritsch, 1987

Objectives

- Document occurrence, frequency and characteristics of extreme convection where ITCZ intersects Andes
  - 14 years of TRMM radar reflectivity and rain type (version 7)

- Describe synoptic conditions leading to these forms of extreme convection
  - ECMWF ERA interim reanalysis to characterize the atmospheric conditions in which extreme convection occurs

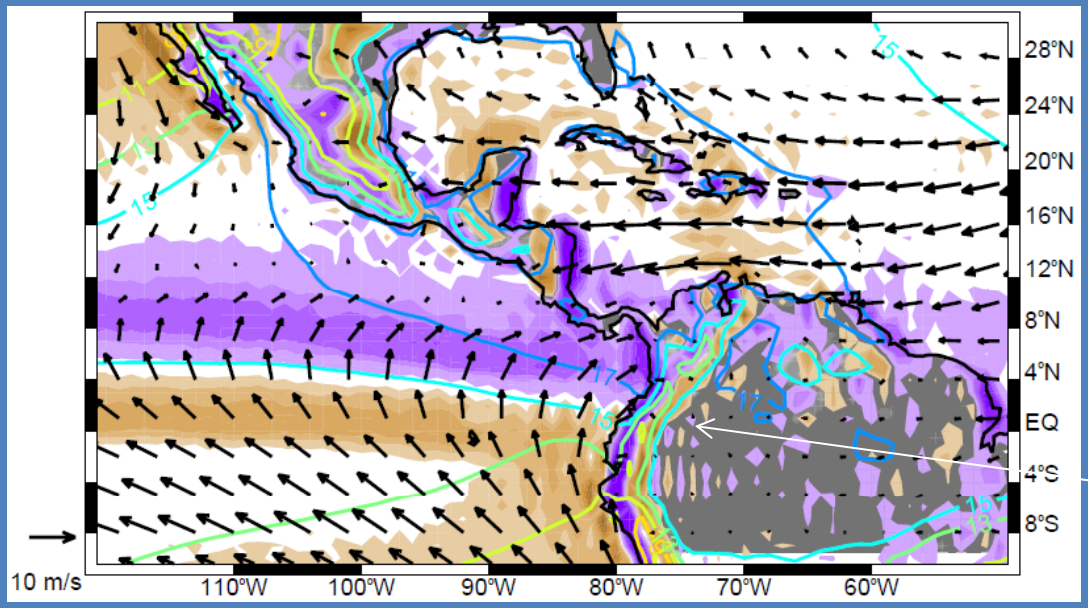
Radar identification of extreme events



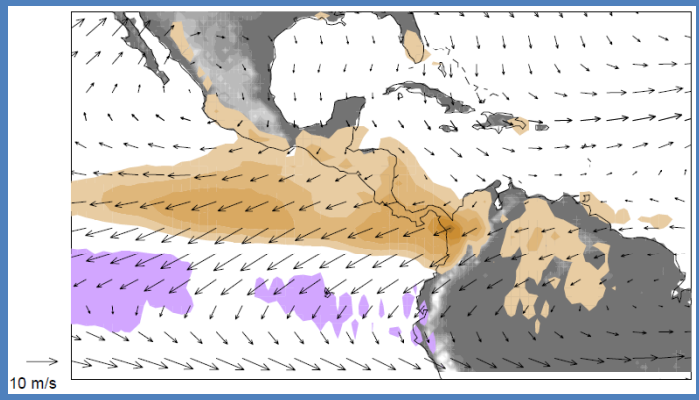
(e.g., Houze et al. 2007; Romatschke et al. 2010)

JJA – ERAi divergence, wind and humidity

Surface

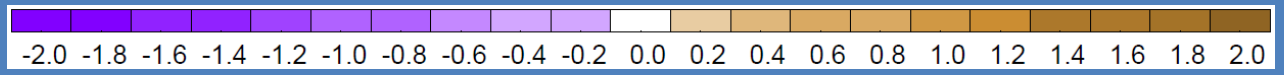


200 hPa



Contours:
Specific humidity [g/kg]

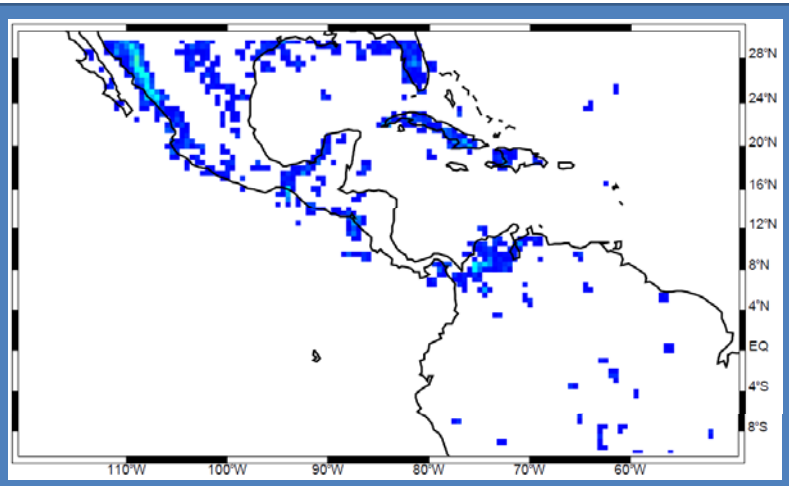
divergence [1/s]



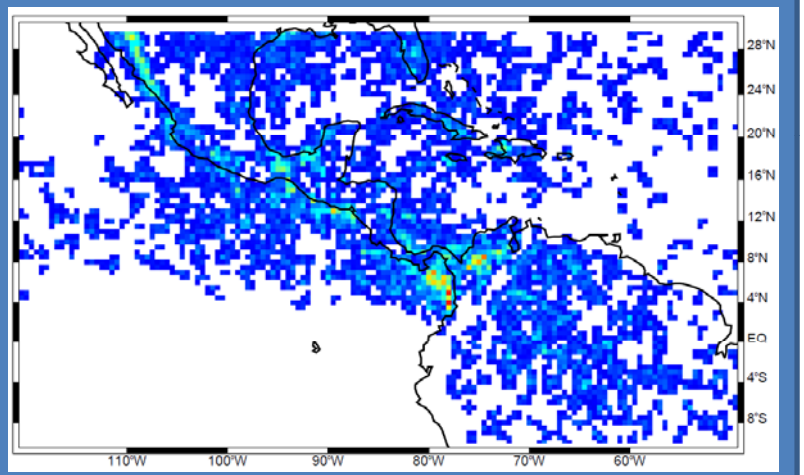
- Trade wind convergence of energy and moisture (Hadley circulation)
- Local concentration: North American monsoon circulation, Intra-Americas jet, and the Chocó low level jet
- Operating in regions of significant low-level moisture gradients areas

Frequency of occurrence

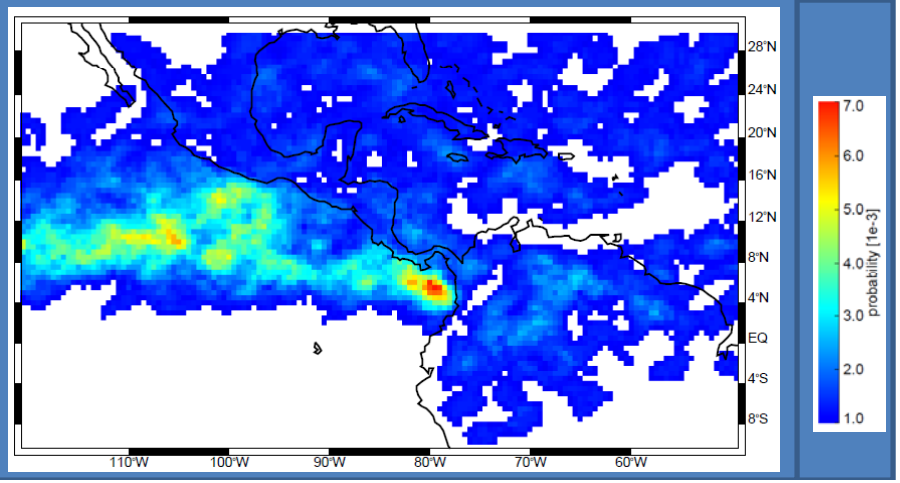
Deep
Convective cores
(DC)



Wide
Convective cores
(WC)



Broad
Stratiform regions
(BS)



- **Deep Convective** cores:
  - West of Sierra Madre range
  - Northern fringes of the Andes
  - Central America
  - Caribbean Islands
  - South Florida
- **Wide Convective** cores:
  - Same regions as DC
  - Amazon region
  - Pacific coast of Colombia and Panamá
- **Broad Stratiform** regions:
  - ITCZ
  - Pacific coast of Colombia and Panamá

Frequency of occurrence

Deep
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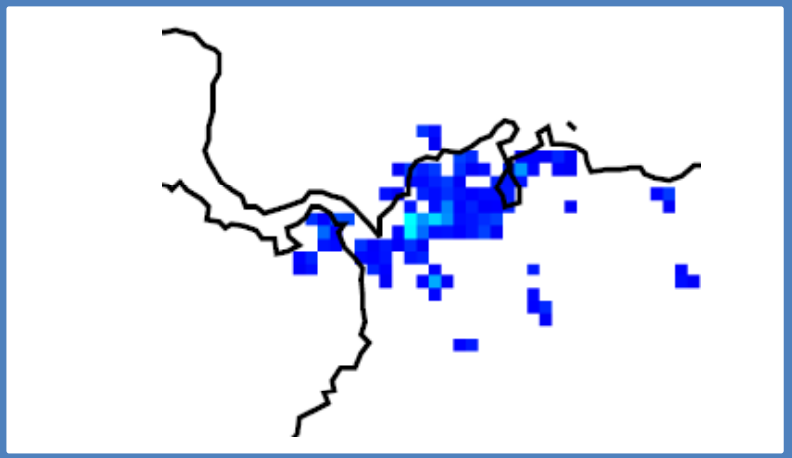
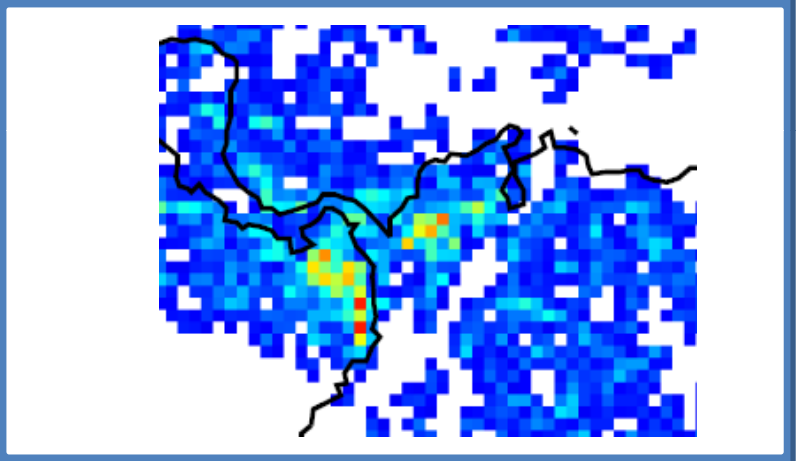
(DC)



- **Deep Convective** cores:

  Northern fringes of Los Andes **(Bajo Cauca region)**

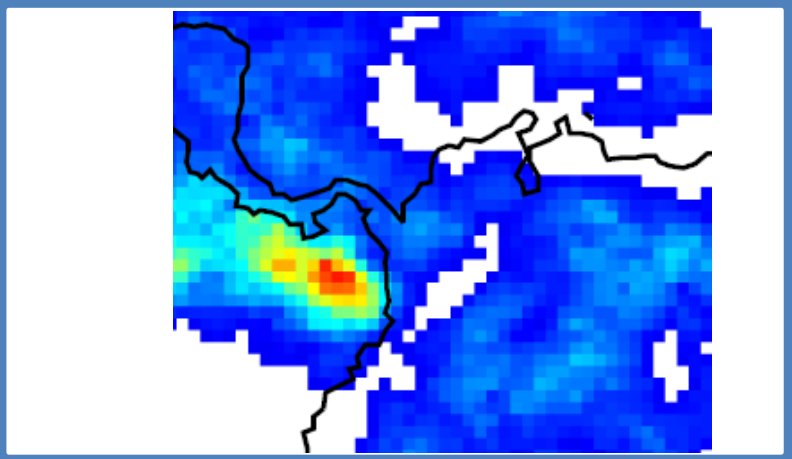
Wide
Convective cores
(WC)



- **Wide Convective** cores:

  Both **Cauca and Chocó regions**

Broad
Stratiform regions
(BS)



- **Broad Stratiform** regions:

  Pacific coast of Colombia and Panamá **(Chocó region)**

Frequency of occurrence

Deep
Convective cores
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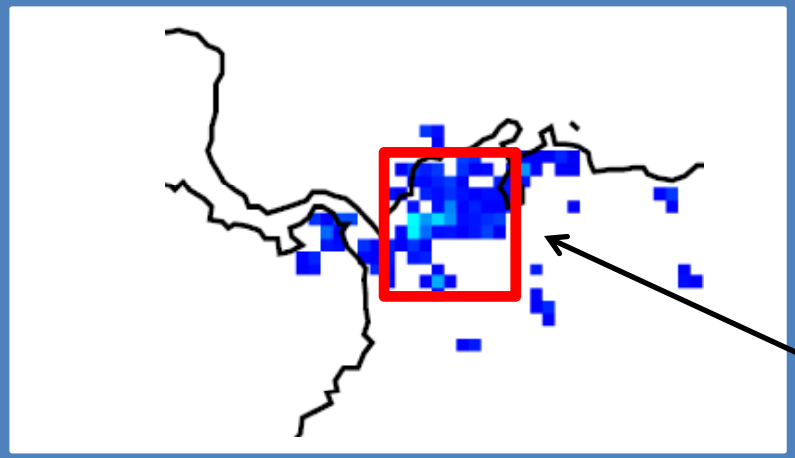

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Northern fringes of Los Andes **(Bajo Cauca region)**

Wide
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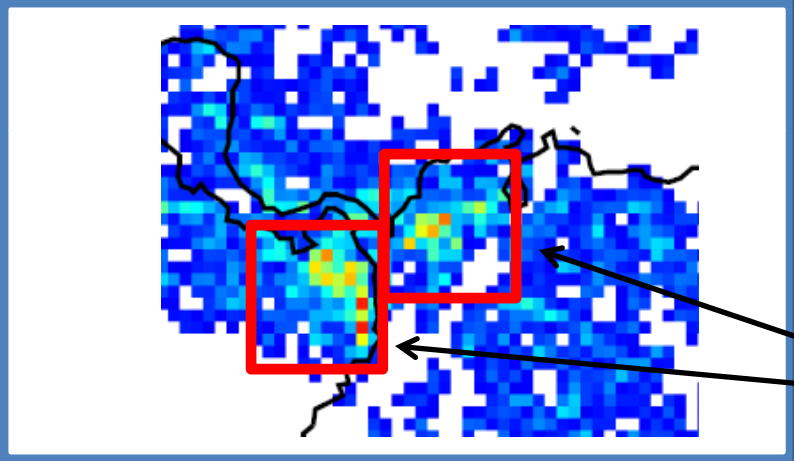

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Broad
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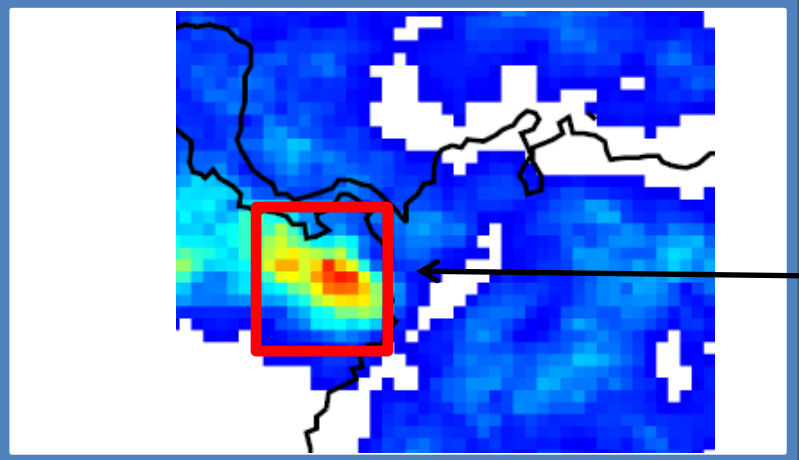
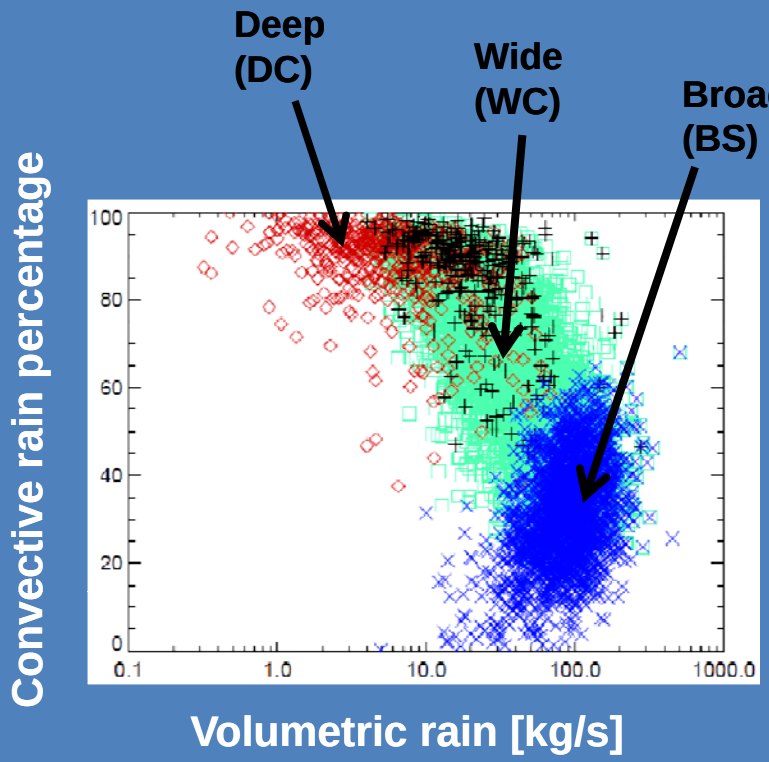


- **Broad Stratiform** regions:

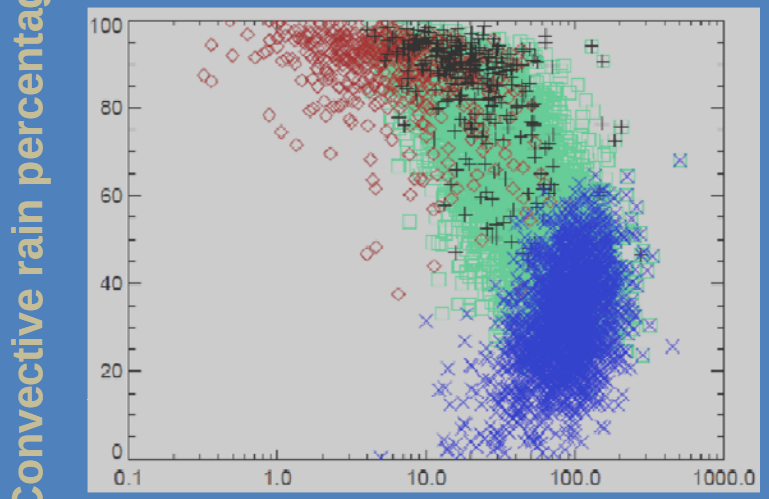
Pacific coast of Colombia and Panamá **(Chocó region)**

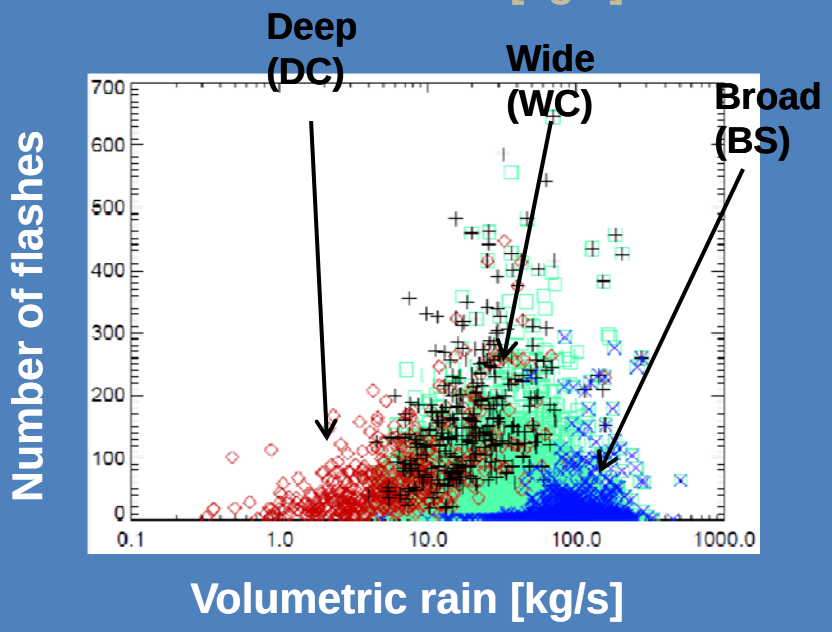


Rainfall, % convective, and echo type

- Storms containing DC cores have very high convective rain percentage but relative low volumetric rain
- In contrast, BS regions have low convective rain but higher volumetric rain rates

Rainfall, % convective, and echo type

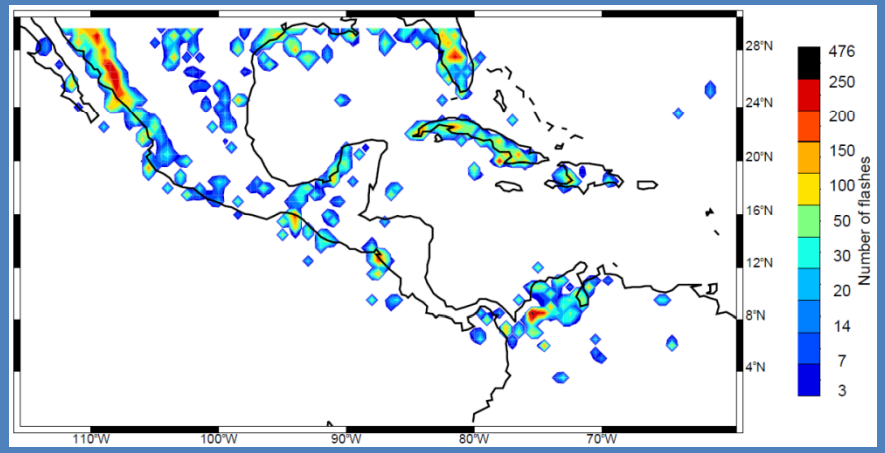




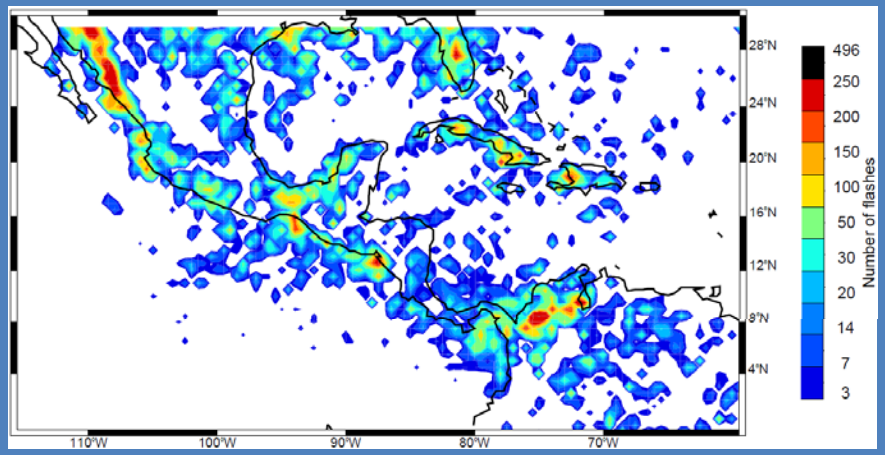
- Storms containing DC cores have very high convective rain percentage but relative low volumetric rain.
- In contrast, BS regions have low convective rain but higher volumetric rain rates.
- Most of the storms with **BS regions** have little to no lightning
- Storms containing **convective cores** are the ones that produce the most lighting

Number of Lightning flashes

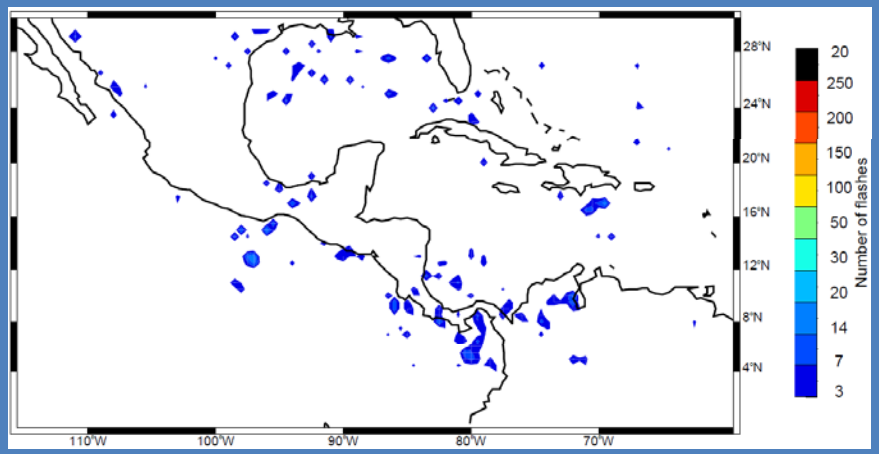
Deep Convective



Wide Convective



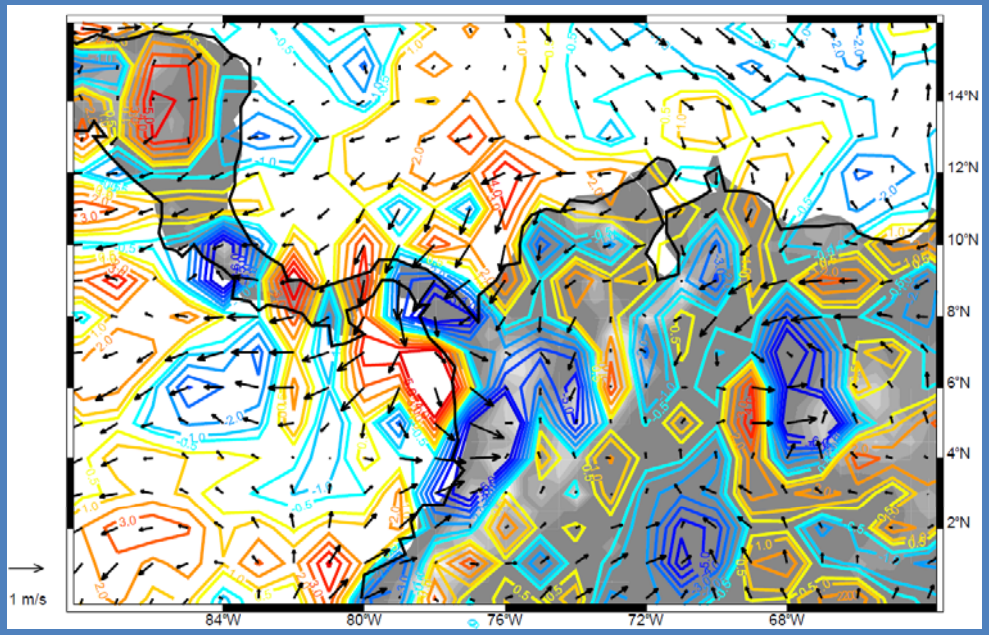
Broad Stratiform



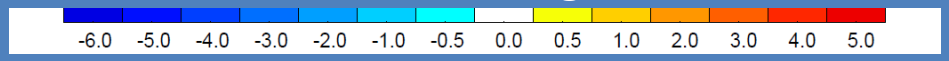
- Lighting flashes directly related with the location of Convective cores
- **WC cores** produce more lightning flashes per area
- **BS regions** produce little to no flashes

Anomaly composites for the closest hour when **DC cores** occurred over the Bajo Cauca region

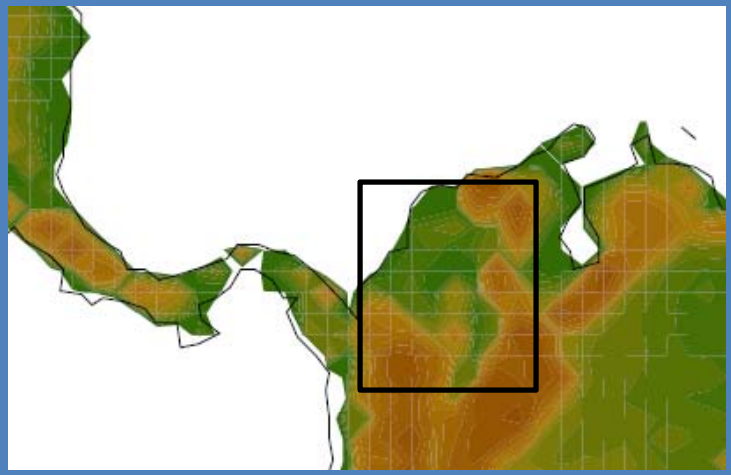
850 hPa



Moisture divergence



Terrain elevation

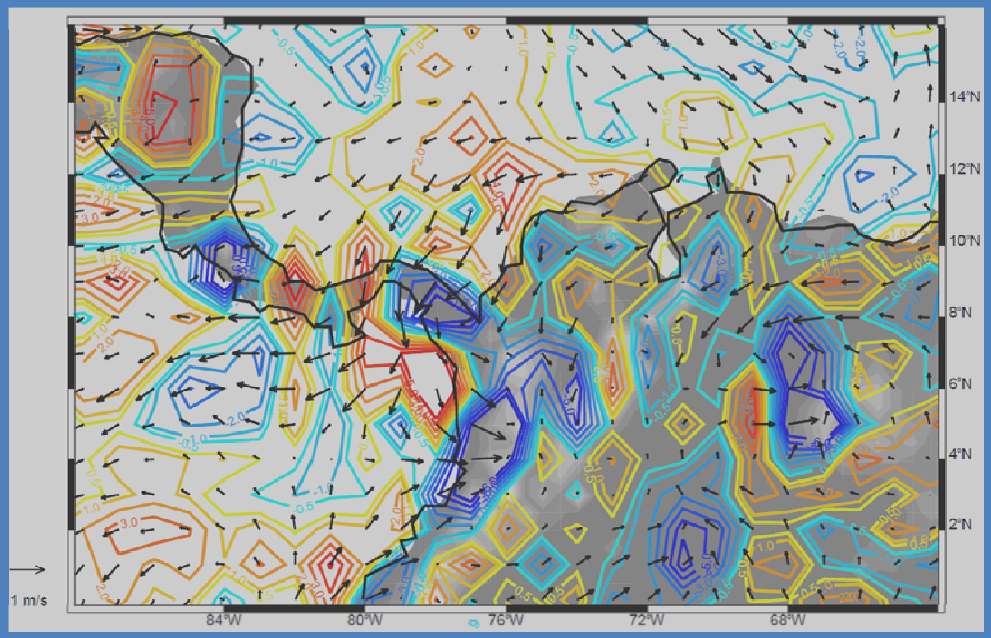


N=30 events

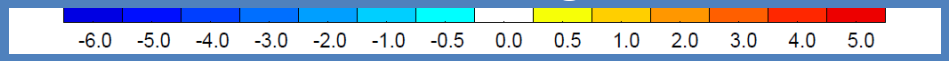
- Anomalous northeasterly flow converging moisture over the northern slopes of the Andes

Anomaly composites for the closest hour when **DC cores** occurred over the Bajo Cauca region

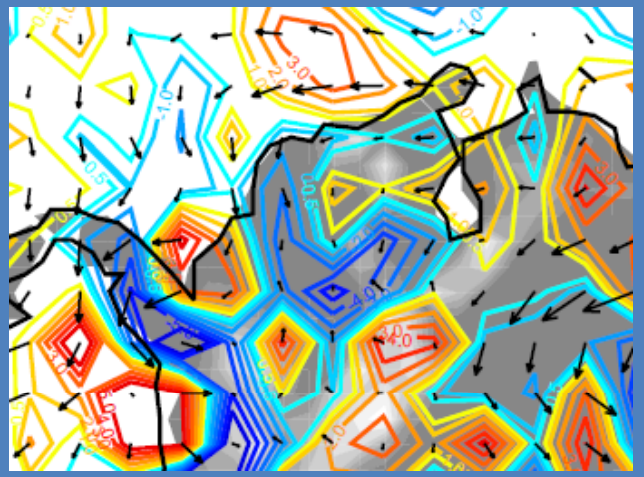
850 hPa



Moisture divergence



850 hPa - 6 hours before

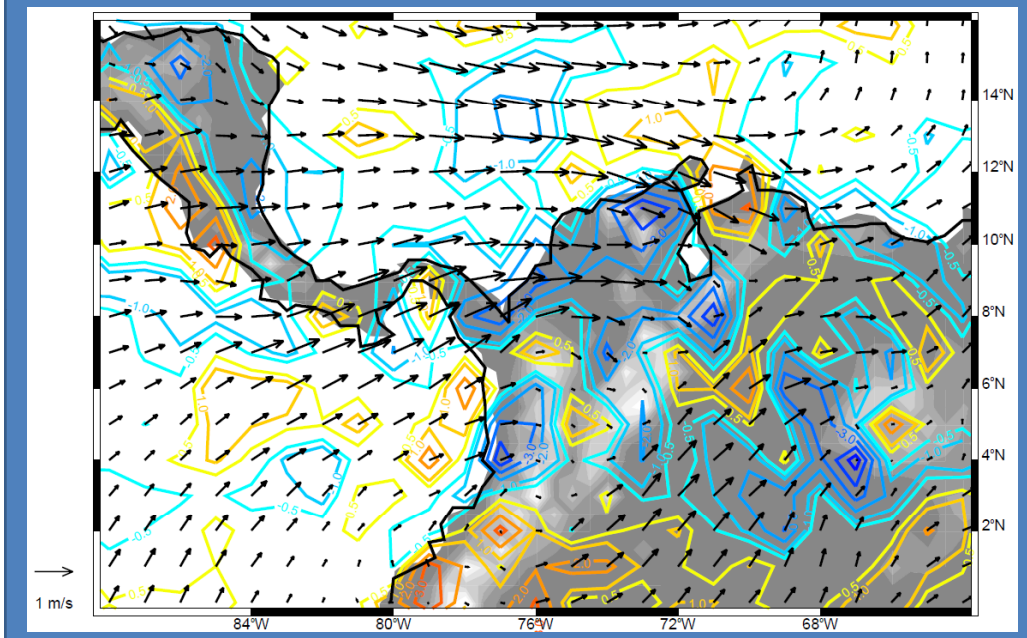


N=30 events

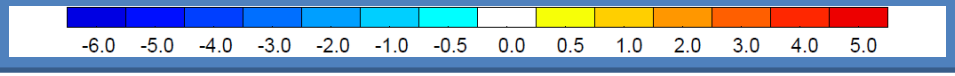
- Anomalous southward flow 6 hours before the event

Anomaly composites for the closest hour when **WC cores** occurred over the Bajo Cauca region

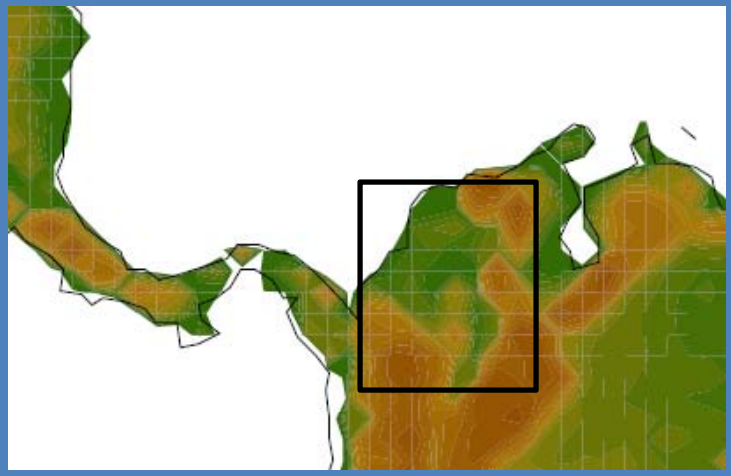
850 hPa



Moisture divergence



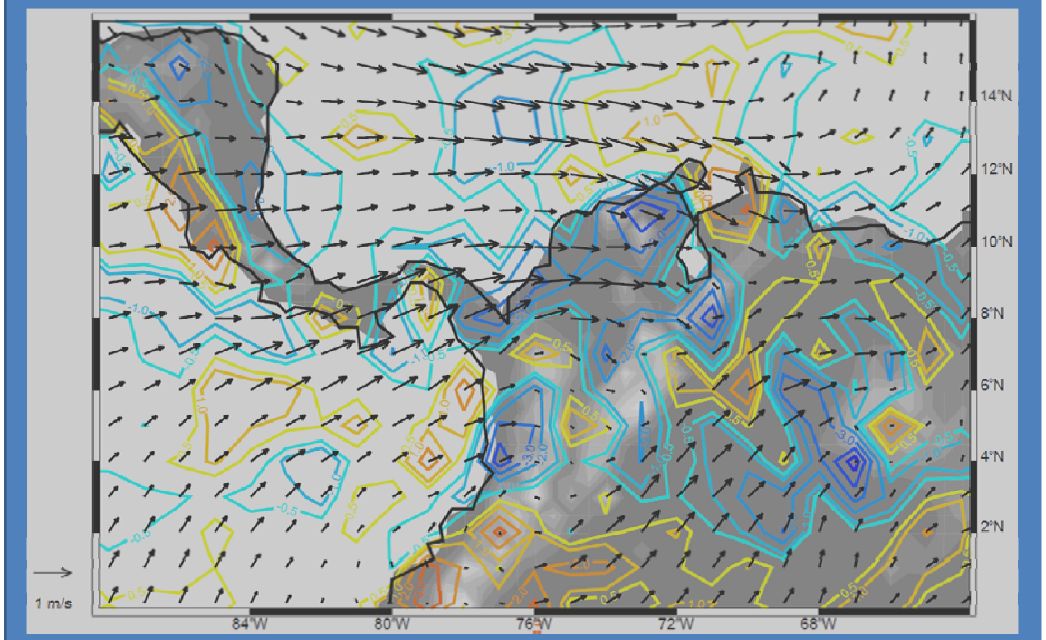
Terrain elevation

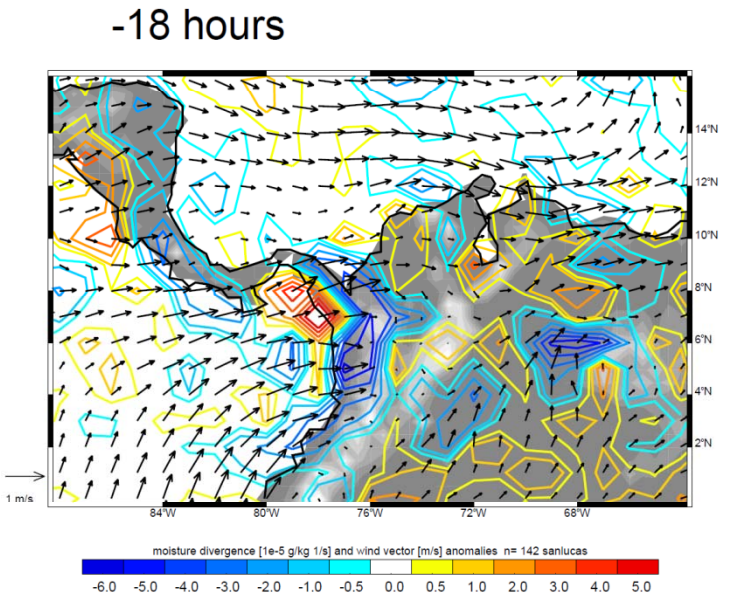


N=142 events

- Significant westerly anomalous flow converging in the low-lands of the northern fringes of the Andes.

Anomaly composites for the closest hour when **WC cores** occurred over the Bajo Cauca region

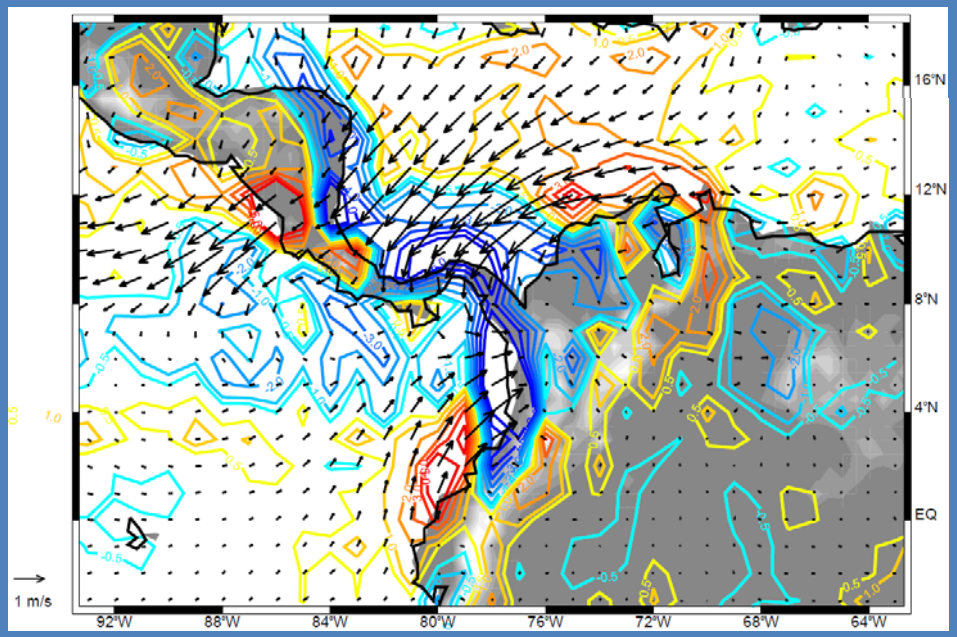




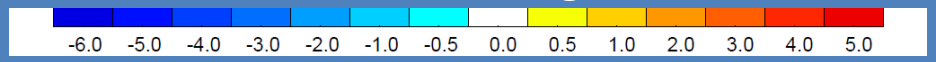
- Shift of convergence from Pacific coast of Colombia towards the Bajo Cauca region

Anomaly composites for days when **WC cores** occurred over the Chocó region

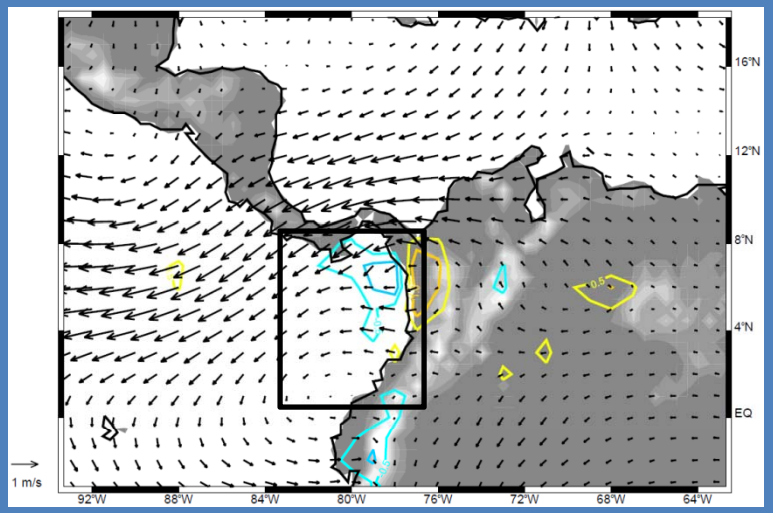
Surface



Moisture divergence



500 hPa

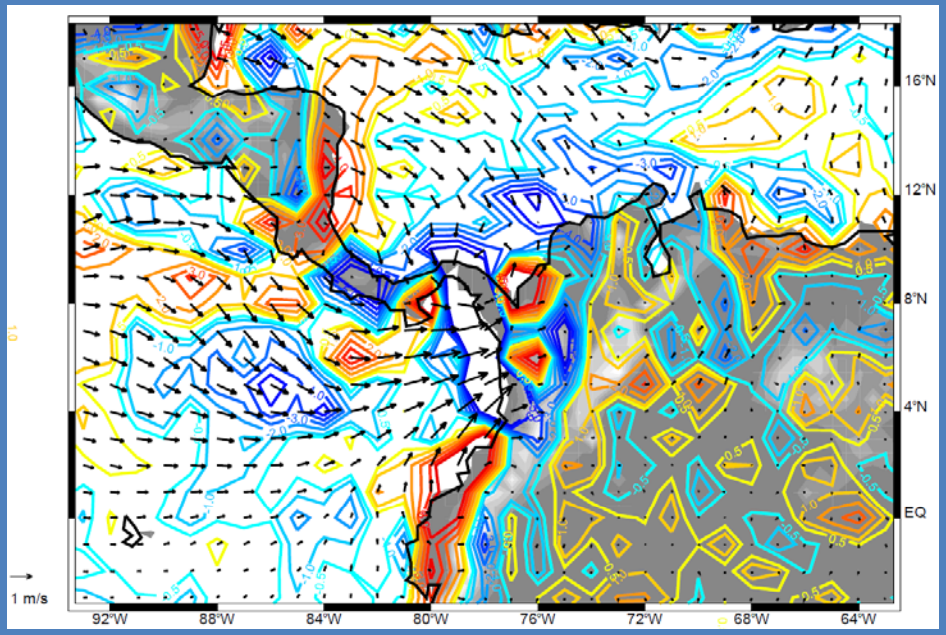


N=165 events

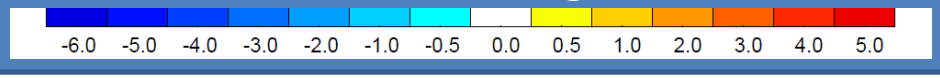
- Events occur in the confluence of recurving branch of the Intra-Americas low level jet from the north and the Chocó Jet from the south

Anomaly composites for days when **BS regions** occurred over the Chocó region

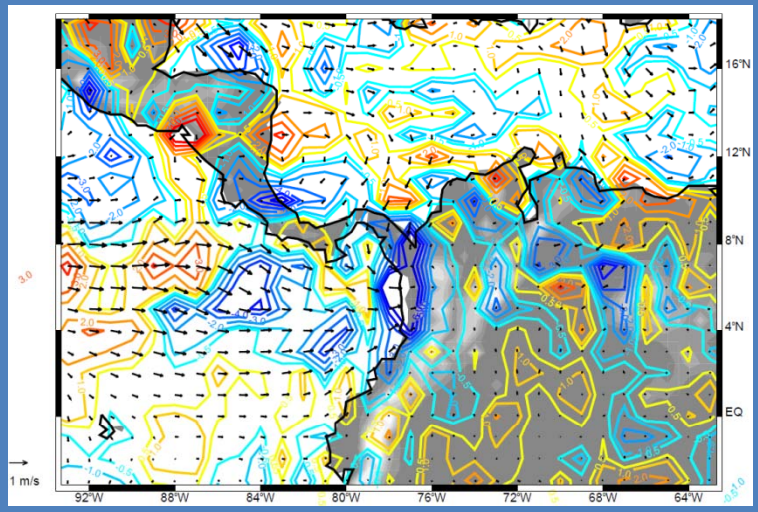
Surface



Moisture divergence



Surface previous day



N=40 events

- Zonally oriented anomalous flow bringing moisture from the Pacific ocean up to the coastal region.

Conclusions

- **Deep convective** cores are located only in the Bajo Cauca region, with a northeasterly flow impinging on the northern end of Los Andes range

- **Wide convective** cores are located in both, Bajo Cauca and Chocó regions, were a recurving branch of the Intra-Americas Jet and the intensification of the Chocó low-level jet concentrate moisture on the west side of Los Andes range

- **Broad stratiform** regions are located mainly over the coast of Colombia and Panamá, region were the Chocó low-level jet runs against the west side of the Los Andes and is enhanced by westerly flow of the ITCZ winds